

PROJECT SUMMARIES

ADAPTIVE MANAGEMENT OF WIRELESS C4ISR NETWORKS

Alex Bordetsky, Associate Professor

Department of Information Science

Sponsor: Aprisma Technologies

OBJECTIVE: Explore network management systems capability to identify intrusion detection patterns within the framework of SNMP MIBs analysis in wireless C4I networks

SUMMARY: The NPS team will setup P2P wireless collaborative network testbed with SNMP agents active at each node of the wireless network. The Spectrum systems security management and case-based reasoning agents will be used to identify the SNMP MIB variables most sensitive to the set of denial of service attacks. The results have to be compared with Aprisma findings on managing North Carolina Internet 2 Giga POP and compiled in network management knowledge base. Recommendations to Situational Awareness agents providing feedback on network state during the attack will complement the research.

DoD KEY TECHNOLOGY AREAS: Command, Control, and Communications

KEYWORDS: Adaptive Network Management, Wireless Collaborative Networks, C4I Networks, SNMP MIBs, Intrusion Detection, Knowledge-Base, Management Agents, Network-Centric Infrastructures

HUMAN-CENTRIC DESIGN OF COLLABORATOR/AGENT INTERFACES

Alex Bordetsky, Associate Professor

Department of Information Science

Sponsor: Space and Naval Warfare Systems Center – San Diego

OBJECTIVE: Explore the decision support requirements to collaborative technology/agent interfaces for multinational peace keeping and humanitarian operations. Develop the plan and detailed proposal for the following on study of adaptive collaboration interfaces for decision-making in multinational experiments.

SUMMARY: The Naval Postgraduate Team will use the results of current Joint Interactive Planning/Rapid Decisive Operation studies of effective collaboration for multinational peacekeeping and humanitarian operations. The findings of committee, team, and group collaborative architectures decision support requirements, cognitive styles, and cultural barriers of collaborators will be used to address the issues of collaborator/agent interfaces experimental studies. Visual collaborative interfaces, multiple agent platform, and case-based reasoning knowledge management facility at NPS will be used to explore specific requirements to the adaptive human-agent interfaces. The study will result in the proposal the proof-of-concept multinational experiments. In addition to the detailed plan of experiments for exploring adaptive human-agent interfaces the proposal will also address design and implementation of multinational conflict resolution collaborative testbed with Swedish National Defense College.

DoD KEY TECHNOLOGY AREAS: Command, Control, and Communications, Modeling and Simulation

KEYWORDS: Collaborative Interfaces, Multiagent System, Case-Based Reasoning, Knowledge Management, Multinational Experiments, Collaborative Technology, Network-Centric Decision Support

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FEEDBACK MECHANISMS FOR AGENT-BASED QOS ADAPTIVE MANAGEMENT OF NETWORKING RESOURCES

Alex Bordetsky, Associate Professor
Department of Information Science
Sponsor: SBC Research Labs

OBJECTIVE: The goal for proposed research is to develop better understanding of how the behavior of two main types of networking nodes, the edge nodes and tandem nodes, could be improved based on the presence of intelligent agents at different observation points within the network. The specific research task is to identify the feedback mechanisms capable of utilizing information gathered by intelligent agents for optimizing network resources usage. The study should focus on the experimental research based on testing and proof-of-concept experiments. The research should provide an experimental background for addressing the problems of networking resources adaptation in Quality of Service Management.

SUMMARY: The project will be conducted in two phases: The project work in phase 1 will be focused on exploring the effects of individual intelligent agents on the usage of edge and tandem node resources. The problems and ways of agents-facilitators communication with SNMP agents and SNMP agents manager will be explored. Effects of agents allocation (concentration) within the network, and usage patterns of agents shared memory will also be investigated.

The second phase will be focused on the effects of intelligent agents cooperation for optimizing the usage of networking resources. How the agents performance and memory responsiveness affect the agents solution on resource reservation along the lines of Call Setup and Connection Control adaptation cycles will be observed. Implementation of how ANN could improve the agents performance in adaptation of networking resources will be explored.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Command, Control and Communications

KEYWORDS: Network Operations Management, Intelligent Agents, Adaptation, Feedback, Agents Memory

INTEROPERABILITY, ARCHITECTURE, AND PLANNING SUPPORT TO SSC CHARLESTON

Rex Buddenberg, Senior Lecturer
Department of Information Science
Sponsor: Space and Naval Warfare Systems Center

OBJECTIVE: To provide support for the fleet NOC and related projects.

DoD KEY TECHNOLOGY AREAS: Command, Control and Communications

KEYWORDS: IT Architecture

CNSG COMPUTER NETWORK DEFENSE INITIATIVE

LCDR Raymond Buettner, USN, Military Faculty
Department of Information Science
Sponsor: Naval Security Group Command

OBJECTIVE: Examine and develop new process for supporting computer network defense (CND) efforts of the U.S. Navy. Identify, evaluate and make implementation recommendations for new CND tactics and mechanisms. This effort will primarily focus on pattern less intrusion detection (PID), external threat assessment (ETA) warning mechanisms and the development of a firewall assessment modeling methodology but may include other efforts as identified by the principal investigator.

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DoD KEY TECHNOLOGY AREAS: Computing and Software

KEYWORDS: Information Operations, Information Warfare, Modeling and Simulation, Computer Network Defense

INFORMATION OPERATIONS MODELING AND SIMULATION

LCDR Raymond Buettner, USN, Military Faculty

Department of Information Science

Sponsor: Office of Naval Research

OBJECTIVE: Examine current modeling and simulation efforts to determine tools that may be useful to the IO/IW community. Analyze suitable modeling and simulation tools to determine those which warrant continued study. For selected applications, develop recommendations and modifications to permit evaluation for use by information warriors. Simultaneously identify models that can increase the quality of IO education either through classroom use or thesis research opportunities.

DoD KEY TECHNOLOGY AREAS: Modeling and Simulation

KEYWORDS: Information Operations, Information Warfare, Modeling and Simulation, Influence Modeling, Reflexive Modeling

INTERNET OPERATIONS PROJECT

LCDR Raymond Buettner, USN, Military Faculty

Department of Information Science

Sponsor: Joint Information Operations Center

OBJECTIVE: Examine and develop processes for developing and applying specialized web sites to existing operational needs as defined by joint and Navy regional and combat CINCs. Identify information operations tactics and procedures to optimize effectiveness of these web sites for full spectrum IO across the range of peace-crisis-conflict.

DoD KEY TECHNOLOGY AREAS: Other (Information Operations)

KEYWORDS: Information Operations, Information Warfare, Modeling and Simulation

GUN WEAPONS SYSTEM COMMAND AND CONTROL PROJECT

Alexander Callahan, Research Assistant Professor

Department of Information Science

Sponsor: Naval Surface Warfare Center – Crane Division

OBJECTIVE: Provide gun weapon system analysis of performance and command and control to include consulting, modeling and simulation.

DoD KEY TECHNOLOGY AREAS: Command, Control and Communications

KEYWORDS: Analysis, Modeling and Simulation

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NAVAL SIMULATION SYSTEM (NSS) DEVELOPMENT AND TESTING

Alexander Callahan, Research Assistant Professor

Department of Information Science

Sponsor: Commander in Chief, Pacific Fleet

OBJECTIVE: To provide development of scenarios and operational testing of the Naval Simulation System. Scope includes planning, modeling, simulation and analysis.

DoD KEY TECHNOLOGY AREAS: Modeling and Simulation

KEYWORDS: Analysis, Modeling, Simulation

NAVAL SURFACE SUPPORT FOR JOINT LAND WARRIOR STUDY

Alexander Callahan, Research Assistant Professor

Department of Information Science

Sponsor: Naval Surface Warfare Center – Crane Division

OBJECTIVE: This study will provide an analysis of the methodology to evaluate the effective use of Naval surface gunfire support of the joint land warrior in expeditionary maneuver warfare. The scope will include the use of modeling and simulation techniques recently developed for the Naval Simulation System (NSS) and other appropriate analytic systems.

DoD KEY TECHNOLOGY AREAS: Modeling and Simulation

KEYWORDS: Naval Simulation System, Joint Land Warrior, Expeditionary Maneuver Warfare

USAREC RECRUITING STRATEGIC VISION PROGRAM (RSVP) WARGAME SIMULATION FOR STRATEGIC PLANNING AND DECISION SUPPORT

Daniel R. Dolk, Professor

Department of Information Science

Sponsor: U.S. Army Recruiting Command

OBJECTIVE: The objective is to create and conduct a reusable, multi-player war game simulation for the Army recruiting leadership (RSVP/ARL). The purpose of this simulation is to explore strategic planning dimensions of the recruiting organization in the Army with the specific goal of being able to provide specific guidelines to the officers attending the annual summer leadership meeting at USAREC. This system will not be a prototype but an operational simulation that will be used and updated on an annual basis. The work on this project will lead to a second phase involving development of a detailed recruiting market simulation (RSVP/RMS) that will allow USAREC to test the virtual effectiveness of various new recruiting-oriented products and market strategies. Leveraging the powerful agency technology of SEAS, this simulation will be able to emulate meaningful market segments and provide valuable insight into relevant market behavior. This will facilitate the preliminary identification of “more promising” vs. “less promising” products prior to the expensive activity of national testing.

DoD KEY TECHNOLOGY AREAS: Manpower, Personnel and Training

KEYWORDS: Agent-Based Simulation, Military Recruiting Policy

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USAREC RECRUITING STRATEGIC VISION PROGRAM RECRUITING WARGAME MARKET SIMULATION (RSVP/RMS) WARGAME

Daniel R. Dolk, Professor
Department of Information Science
Sponsor: U.S. Army TRADOC Analysis Command

OBJECTIVE: This is the second phase of the RSVP project for implementing strategic business war-games at USAREC. The objective of this phase is to develop a detailed recruiting market simulation (RSVP/RMS) that will allow USAREC to test the virtual effectiveness of various new recruiting-oriented products and market strategies. Leveraging the powerful agent technology of the SEAS environment, this simulation will be able to emulate meaningful market segments and provide valuable insight into relevant market behavior. This will facilitate the preliminary identification of “more promising” vs. “Less Promising” products prior to the expensive activity of national testing.

SUMMARY: Two major thrusts have occurred in this project: (1) a 2nd version of the strategic war game simulation (SWGS) to be presented in September 2002, and (2) an operational decision support system (ODSS) for the CG of USAREC. The user interface for the ODSS and for presenting results of the SWGS are identical. This allows a seamless transition from viewing data about real world operations, as contained in the USAREC data warehouse, and viewing data from simulations that implement various recruiting policies and decisions specified by the war game players.

DoD KEY TECHNOLOGY AREAS: Manpower, Personnel and Training, Modeling and Simulation, Human Systems Interface

KEYWORDS: Agent-Based Simulations, OLAP, Military Recruiting Policy

DEVELOPMENT OF THE HCDA FOR THE MANNING AFFORDABILITY PROJECT Sue Hutchins, Research Associate Professor

Department of Information Science
Sponsor: Naval Air Warfare Center - Training Systems Division

OBJECTIVE: The focus of this year’s effort will be collecting additional case studies to illustrate potential system design problems and working with the HCDA design team to translate the case studies to a format that will be useful for incorporation into the HCDA. The case studies are to represent the range of design problems found in complex military command and control systems and the ways in which these types of problems can be avoided in future system design.

SUMMARY: The overall purpose of this effort is to support the development of the Human-Centered Design Associate (HCDA), an intelligent software agent designed to provide human factors knowledge and expertise to a system designer. In particular, there are three tasks. The first task is to provide human factors case studies of system design to populate the database of the intelligent search agent component of the HCDA. The second task is to provide guidance in the search for additional high payoff areas within the system design process that can be supported with HCDA components. The third task is to support the testing and evaluation of each component of the HCDA.

DoD KEY TECHNOLOGY AREAS: Human Systems Interface

KEYWORDS: Human Factors, Automation, Decision Theory/Support System, Command and Control, Human-System Interface

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COMMANDING AND CONTROLLING 21st CENTURY MILITARY FORCES : THE COMMAND AND CONTROL – EMERGING EFFECTS FRAMEWORK

Erik Jansen, Senior Lecturer
Carl R. Jones, Professor
Michael G. Sovereign, Professor Emeritus
Department of Information Science
Sponsor: Unfunded

OBJECTIVE: Develop an analytical framework to describe, design, operate, and adapt military forces for mission success in a 21st century ecology of conflict and cooperation.

SUMMARY: The Command and Control – Emerging Effects (C2E2) framework is comprised of concepts for (1) organizing the force in terms of a problem-focused logic, (2) embedding the organized logic in a physically realizable force architecture with specifications for manpower and technical systems, (3) understanding the executable force as a resourced force architecture comprised of control – coordination processes and a command process observed as a dialogue involving interpreting, assessing, deciding, leading, and collaborating, and (4) the executing operational force. The force's evolution is an element of the evolution of the ecology of conflict and cooperation with emerging effects among friends, foes, and neutrals. The C2E2 framework can be used to understand such phenomena as force vulnerability, adaptation, self-organizing, self-synchronization, knowledge and information engineering and management, network centric warfare, and effects-based warfare.

DoD KEY TECHNICAL AREAS: Battlespace Environments, Command, Control, and Communication, Modeling and Simulation

KEYWORDS: Command, Control, Command and Control, Joint Technical Architecture, C4ISR Systems, Organizational Sciences, Management, Leadership, Ecological Evolution, Complex Adaptive Systems

DEVELOPMENT OF AN ADVANCED PROOF-OF-CONCEPT WORLD WIDE WEB PROTOTYPE APPLICATION FOR ONLINE RECRUITING

Magdi N. Kamel, Associate Professor
Department of Information Science
Sponsor: U.S. Military Entrance Processing Command

OBJECTIVE: The objective of this research is to develop an advanced proof-of-concept world wide web prototype application to support prospecting, attracting, screening, closing the sale, and processing of new Navy recruits.

DoD KEY TECHNOLOGY AREAS: Computing and Software

KEYWORDS: Application and Development, World Wide Web, Internet, E-Commerce, Military Recruiting

DEVELOPMENT OF A REPEATABLE EDUCATION AND TRAINING NEEDS ASSES SMENT PROCESS FOR SPAWAR INFORMATION TECHNOLOGY

Magdi N. Kamel, Associate Professor
Department of Information Science
Sponsor: Space and Naval Warfare Systems Command

OBJECTIVE: The objective of this research is to develop a repeatable education and training needs assessment process for the ITC workforce.

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DoD KEY TECHNOLOGY AREAS: Computing and Software

KEYWORDS: Needs Assessment, Requirements Identification, Education, Training

ADAPTIVE ARCHITECTURES FOR COMMAND AND CONTROL (A2C2)

William Kemple, Associate Professor

Department of Information Science

Sponsor: Office of Naval Research

OBJECTIVE: To investigate adaptation in joint C2 architectures and to develop theories of C2, i.e., “Congruence” of task organization. To use modeling to identify near-optimal organizational decisions for C2 tasks. Other goals include testing the theories and models in a series of experiments and supporting implementation of adaptable C2 architectures.

SUMMARY: The Adaptive Architectures for Command and Control (A2C2) research project is a multi-year program of basic and applied research featuring model-based experimentation and including “outreach” to DoD/DoN operational, experimental and concept development activities. The program is a collaborative effort involving industry, university and government researchers. Program goals include: 1) extending 14+ years of naval composite warfare decision-making research into the Joint Command and Control (C2) arena; 2) focusing on adaptive architectures within decision-making organizations; and 3) producing results that range from the purely theoretical to those that can be used by operational forces. The prototype A2C2 experiment design combines an operational scenario, computer-based architecture models and model-based predictions of the performance of those architectures on the operational scenario. The experiment tests these architectures in a series of human-in-the-loop experiments using military officers operating in a Joint setting as the test subjects and also provides feedback to the models.

DoD KEY TECHNOLOGY AREAS: Human Systems Interface

KEYWORDS: Command and Control, Joint Operations, Organizational Experiments

NAVAL POSTGRADUATE SCHOOL EFFORT TO SUPPORT GLOBAL WARGAME 2001

William Kemple, Associate Professor

Sue Hutchins, Research Associate Professor

Department of Information Science

Sponsor: Office of Naval Research

OBJECTIVE: NPS support for global wargame 2001 will consist of two components: The first component involves direct support to advancing A2C2 research; the second involves providing support to the joint force command J9 effort.

SUMMARY: New warfighting concepts are currently under development at U.S. Joint Forces Command (JFCOM), J9, Joint Experimentation Directorate, to support the U.S. military as it transitions to the Fighting Force described in Joint Vision 2020. Joint Vision 2020 stresses the need for achieving full spectrum dominance, where forces support the military capability to perform missions from peacekeeping to conflict deterrence prevention to fighting and winning against fully capable enemies. This is to be accomplished by using the latest advances in computer technology, information superiority, improved jointness, precision operations, dominant maneuver, focused logistics, and full-dimension protection. Implementation of these new concepts will occur via new ways of organizing the Joint Force, new processes, and the use of tools and advanced technology to support their implementation.

Future operations will be characterized by unique, one-of-a-kind actions, with changing/ diverse partners, based on uncertain data and requiring quick response on high-impact issues. Characteristics of this new environment include: operations with joint, coalition, non-government, and volunteer organization partners; a shift from extended engagement with a single opponent to local discrete events; dealing with open-source (uncertain, conflicting, partial, non-official) data; rapidly changing team members

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and associated organizational structures; culturally diverse partners; and short turn-around, high stakes, politically charged decision making. A series of experiments and exercises is being conducted to help refine the new concepts and processes under development at JFCOM. Each experiment is designed to support assessments of future capabilities and modification of current doctrine, organization, materiel, leadership, and procedures.

DoD KEY TECHNOLOGY AREAS: Other (Information Technology)

KEYWORDS: Network-Centric Operations, Operational Decision Making, Knowledge Wall

ADVANCED COMMAND AND CONTROL (AC2) RESEARCH SUPPORT

William Kemple, Associate Professor

Department of Information Science

Susan Hovevar, Associate Professor

Graduate School of Business and Public Policy

Sponsor: Chief of Naval Operations (N6)

OBJECTIVE: The purpose of this research is to advance our understanding of the implications of network centric operations to command and control. This will be accomplished through an integrated experiment process that links advanced concept seminar-type wargames with simulation-based wargame experiments. OPNAV N6 has identified particular areas of interest to include: Highlight risks and opportunities for C2, explore unintended consequences, identify guiding principals (i.e., Rules, models, metrics), clarify and articulate assumptions and relevant uncertainties.

SUMMARY: Modified human decision-making processes are required—in addition to new tactics and technology that are also currently under development—to enable Joint military forces to operate in a time span that is shorter than an adversary's. Self-synchronization is viewed as an essential process within military organizations that can increase speed of command and thus accelerate execution of the mission. This process of self-synchronization is described as the ability of a well-informed force to organize and synchronize complex warfare activities from the bottom up. The organizing principles are unity of effort, clearly articulated commander's intent, and carefully crafted rules of engagement. Self-synchronization is viewed as a mechanism to overcome the loss of combat power inherent in top-down, command-directed coordination that is characteristic of conventional command and control doctrine. One enabler of self-synchronization is a high level of knowledge of one's own forces, enemy forces, and all appropriate elements of the operating environment. This new style of coordination offers the potential to convert combat from a step function to a high-speed continuum.

An experiment in support of CNO N6C's Advanced Command and Control (AC2) Study was conducted. The objective of the AC2 study is to investigate the nature of command and control as the US Navy evolves toward a network-centric concept of future maritime operations. The focus of the experiment was the conditions (or "enablers") that promote decisionmakers' ability to self-synchronize their efforts. This concept of self-synchronization was examined within the context of a task force responding to time-critical strike and theater air-missile defense missions. An innovative "hybrid" approach that combined concept development seminar games with an experiment process composed of integrated activities, tools, and methods that capitalize on the NPS research team's capabilities, was used to support an area requiring investigation by OPNAV, N6C. A multi-disciplinary approach, including seminar games, models and simulations, interviews, surveys, and other knowledge capture method, matches these methodologies to the requirements of the AC2 study.

DoD KEY TECHNOLOGY AREAS: Command, Control and Communication

KEYWORDS: Command and Control, Modeling and Simulation

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RED CELL ANALYSIS OF DISRUPTIVE TECHNOLOGIES IDENTIFICATION OF POTENTIAL ADVERSARY SYSTEMS AND TECHNOLOGIES TO DISRUPT U.S. NAVAL OPERATIONS

John S. Osmundson, Associate Professor

D. C. Schleher, Professor

Department of Information Science

Robert C. Harney, Senior Lecturer

Wayne E. Meyer Institute of Systems Engineering

Sponsor: Naval Warfare Development Command

OBJECTIVE: Assess disruptive technologies that might be employed in the 2015 time frame to deny access to the U.S. Navy. Compare the list of disruptive technologies to and reconcile with U.S. intelligence agencies' assessments.

SUMMARY: This study was directed at identifying and analyzing commercial-off-the-shelf and readily available technologies that might be available to a U.S. adversary in the 2007 to 2015 timeframe to use in a disruptive manner in an anti-access role against U.S. Naval forces. Five dimensions of battlespace were considered: Surface (land and sea), subsurface (land and sea), air, space and cyberspace. Estimates were made of the probability of employment of each of the systems and technologies based on maturity of the systems and technologies, probable costs and development schedules and any other relevant factors. Previous Naval Postgraduate School student area denial study results, published lists of critical technologies, and brainstorming by Naval Postgraduate faculty and systems engineering integration (SEI) students were used as inputs to this study. The approach taken was to encourage "thinking out of the box" rather than relying on observed evidences of potential threats.

Systems and technologies were evaluated in terms of their impact on U.S. forces in an anti-access mode and their probability of occurring. Systems ranked high in both impact and probability of occurrence were analyzed further, where appropriate, to determine estimates of system parameters. Twenty four systems, technologies and attack mechanisms were determined to be high risk to U.S. naval forces. Sixteen systems, technologies and attack mechanisms were found to be medium risk.

PUBLICATIONS:

Osmundsen, J.S, Schleher, D.C. and Harney, R.C., *Identification of Potential Adversary Systems and Technologies to Disrupt US Naval Operations, ANTI-ACCESS SYSTEMS STUDY*, Naval Postgraduate School Technical Report, NPS-JW-01-015, 31 January 2001.

DoD KEY TECHNOLOGY AREAS: Air Vehicles, Space Vehicles, Battlespace Environments, Computing and Software, Conventional Weapons, Electronic Warfare, Directed Energy Weapons, Sensors, Surface/Under Surface Vehicles - Ships and Watercraft

KEYWORDS: Red Cell Analysis, Disruptive Technologies

DETECTION OF LPI RADAR SIGNALS

D. C. Schleher, Professor

Department of Information Science

Sponsor: National Reconnaissance Office

OBJECTIVE: To design and synthesize an ELINT receiver capable of detecting LPI radar signals with the same sensitivity as available on equivalent conventional pulsed signals. To accomplish this detection in the presence of a large number of interfering conventional pulsed radars and to measure the radar's mode, allowing the operating range of the LPI radar to be determined.

SUMMARY: An adaptive LPI Radar Detector has been synthesized and successfully simulated. As determined by simulation, it provides an operationally significant range of 60 km on a known LPI radar signal. In addition, it determines the LPI radar's mode. A temporal mask approach is used to allow

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detection of the LPI radar signal in the presence of over 500 Furono radars with random modes. An experimental demonstration was successfully conducted that confirmed the theoretical design. The experiment used a threat simulator that radiated synthesized LPI radar signals. The LPI signals were intercepted by a Low Noise Receiver and A/D converter using a 250 MHz Gage Digital Sampling Oscilloscope. The signal was then processed in a digital signal processor using MATLAB code. LPI signals at a level of -108 to -120 dBm were detected and the radar's mode determined.

THESIS DIRECTED:

Teng, H. and Ong, P., "Digital LPI Radar Detector," Masters Thesis, Naval Postgraduate School, March 2001.

DoD KEY TECHNOLOGY AREA: Command, Control and Communication

KEYWORDS: SIGINT, LPI Radar, Digital Pulse Compression, Surveillance

JAMMING TACTICS AND EMPLOYMENT OF UEU AGAINST ADVANCED RADAR AND COMMUNICATIONS SYSTEMS

D. C. Schleher, Professor

Department of Information Science

Sponsor: Navy Information Warfare Activity

OBJECTIVE: Develop UEU employment tactics and advanced jamming techniques to counter communications, data links and advanced J-Band threats.

SUMMARY: A number of advanced threats susceptible to the new UEU jammer capability available in the EA-6B were identified. These include advanced radars using pulse compression and pulsed Doppler type waveforms. Communications jamming is accomplished using the UEU to generate stable narrow band frequency spots with minimum spurious components that prevent interference with friendly communications systems. Data links can be jammed using pulse patterns generated by the UEU. Further research will identify specific waveforms and tactics to exploit the new capabilities available using the UEU.

DoD KEY TECHNOLOGY AREA: Other (Electronic Warfare)

KEYWORDS: EW, Communications Jamming

POSITIONAL ACCURACY OF TDOA MISSILE SYSTEM

D. C. Schleher, Professor

Department of Information Science

Sponsor: Naval Air Warfare Center - Weapons Division

OBJECTIVE: To analyze and synthesize an FDOA/TDOA system capable of providing a 1 m rms position accuracy from telemetry signals radiated from a test missile during flight test. Also, to investigate the accuracy of a Time, Space and Position Information (TSPII) system developed by NAWC Weapons Division, China Lake.

SUMMARY: A lower bound on the accuracy achievable using a nine base station configuration, employed at White Sands Missile Range, as a function of signal-to-noise ratio was determined. The simulation used a missile trajectory determined from measured laser tracker data. The methodology used in the simulation was to determine FDOA from each base station with respect to the reference station and then to use this to determine the TDOA of the missile. This was used in the Smith-Able algorithm to determine the position of the missile. A signal-to-noise ratio of 40 dB was required to achieve a one meter rms positional accuracy of the missile's location. The TSPI system was found to be limited by the susceptibility of the

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zero crossing counter to noise and fading and the use of a wideband telemetry signal source in the missile. A system using a stable source in the missile modulated by a pseudo noise code was synthesized. This is currently under investigation using modeling and simulation techniques. An experimental test of this system is planned using a digital receiver approach.

THESIS DIRECTED:

Klaszky, R., "Analysis of the Positional Accuracy of a Range Difference Missile Position Measuring System," Masters Thesis, Naval Postgraduate School, September 2000.

Heng, C., "Kalman Filtering of FDOA/TDOA Missile Tracking System," Masters Thesis, Naval Postgraduate School, March 2001.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: TDOA, FDOA, Missile Location, TSPI, Digital Receiver

DEVELOPMENT OF SOFTWARE RELIABILITY MODEL ENHANCEMENTS

Norman Schneidewind, Professor

Department of Information Science

Sponsor: National Aeronautics and Space Administration - Goddard Space Flight Facility

OBJECTIVE: Develop and implement enhancements to the Schneidewind Software Reliability Model.

SUMMARY: In general, software reliability models have focused on modeling and predicting failure occurrence and have not given equal priority to modeling the fault correction process. However, there is a need for fault correction prediction, because there are important applications that fault correction modeling and prediction support. These are the following: predicting whether reliability goals have been achieved, developing stopping rules for testing, formulating test strategies, and rationally allocating test resources. Because these factors are related, we integrate them in our model. The modeling approach involves relating fault correction to failure prediction, with a time delay between failure detection and fault correction, represented by a random variable whose distribution parameters are estimated from observed data. The contribution is the quantification of the relationship between fault correction delay and reliability goals, which provides the software engineer with information for making informed decisions about meeting reliability goals, developing test strategies, and allocating test resources. In addition, we contribute to the state of the practice by providing a model with both failure detection and fault correction predictions.

PUBLICATIONS:

Schneidewind, N.F., "Modelling the Fault Correction Process," *Proceedings of the Twelfth International Symposium on Software Reliability Engineering*, pp. 185-190, Hong Kong, 27-30 November 2001.

Schneidewind, N.F., "Using Excel to Implement Software Reliability Models," *Notes of the Workshop on Software Assessment, the Twelfth International Symposium on Software Reliability Engineering*, Hong Kong, 27-30 November 2001.

Schneidewind, N.F., "A Roadmap To Distributed Client-Server Software Reliability Engineering," *Tutorial Notes of Quality Week 2001*, San Francisco, CA, 29 May 2001.

Schneidewind, N.F., "Introduction to Software Reliability with Space Shuttle Example," *Tutorial Notes of the 2001 Reliability and Maintainability Symposium*, IEEE Reliability Society, Philadelphia, PA, 23 January 2001.

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PRESENTATIONS:

Schneidewind, N.F., "Introduction to Software Reliability Engineering with Space Shuttle Example," Temasek Laboratories, National University of Singapore, 3–4 December 2001.

Schneidewind, N.F., "Software Risk and Maintenance Stability Analysis," Temasek Laboratories, National University of Singapore, 3–4 December 2001.

Schneidewind, N.F., "Everything You Wanted to Know About SRE But Didn't Know Who to Ask", Twelfth International Symposium on Software Reliability Engineering, IEEE Computer Society Press, Hong Kong, 27-30 November 2001.

DoD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Software Reliability, Modeling

DEVELOPING THE NEXT GENERATION IEEE DEPENDABILITY STANDARD: IEEE 982 STANDARD DICTIONARY OF MEASURES OF THE SOFTWARE ASPECTS OF DEPENDABILITY

**Norman Schneidewind, Professor
Department of Information Science
Sponsor: IEEE Standards Board**

OBJECTIVE: Develop an IEEE Software Engineering Standard for Software Dependability.

SUMMARY: This first phase of the project involves the development of measures to address reliability, maintainability, and availability. The second phase will address security, integrity, and confidentiality. This standard builds upon the IEEE 982.1 Standard Dictionary of Measures to Produce Reliable Software, but will delete outdated measures, modernize the standard with object-oriented measures, and modify measures where appropriate. Because 982 was originally issued in 1988 and has not been revised since then, much of it is obsolete. Thus, there is the need to both update existing measures and to include new measures that reflect developments in software technology since 1988. Applying the criteria on how a measure is chosen for inclusion in the dictionary, we have performed a measure-by-measure review and have added, modified, and deleted measures in the dictionary.

DoD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Standards, Software Reliability

ESTIMATING AND CONTROLLING SOFTWARE FAULT CONTENT MORE EFFECTIVELY

**Norman Schneidewind, Professor
Department of Information Science
Sponsor: Jet Propulsion Laboratory, California Institute of Technology**

OBJECTIVE: The goals are to develop techniques that can be used earlier in a development effort to estimate software quality attributes, particularly focusing on the way requirements changes affect software quality, and to identify relationships between specific types of structural changes to a system and the types of faults inserted into it.

SUMMARY: Software metrics have been shown to predict software quality attributes (e.g., reliability, fault content), but most of these measurements taken are of source code. However, they do not help identify the types of faults inserted into software during its development. More effective software quality control depends on the ability of measuring artifacts produced before implementation

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The goals were to develop techniques that can be used earlier in a development effort to estimate software quality attributes, particularly focusing on the way requirements changes affect software quality, and to identify relationships between specific types of structural changes to a system and the types of faults inserted into it. These goals were accomplished by developing and publishing models that use requirements change risk factors as predictors of reliability. In addition, the relationship between requirements change risk factors and software metric critical values was modeled. It was shown that when these critical values are exceeded, it is indicative of unreliable software.

PUBLICATIONS:

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Schneidewind, N.F., "Maintenance Process and Product Evaluation Using Reliability, Risk, and Test Metrics," *Advances in Computers*, Academic Press, Vol. 54, pp. 153-181, 2001.

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PRESENTATIONS:

Schneidewind, N.F., "SRE of Web Site Construction," Twelfth International Symposium on Software Reliability Engineering, Hong Kong, 27-30 November 2001.

Schneidewind, N.F., "Investigation of the Risk to Software Reliability and Maintainability of Requirements Changes," International Conference on Software Maintenance, Florence, Italy, 7-9 November 2001.

Schneidewind, N.F., "Web Site Maintainability," Seventh Workshop on Empirical Studies of Software Maintenance, Florence, Italy, 9 November 2001.

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DoD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Software Reliability, Software Metrics, Modeling

MAINTENANCE ERROR INFORMATION MANAGEMENT SYSTEM

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Sponsor: Federal Aviation Administration

OBJECTIVE: To design a distributed database management system that would capture maintenance factors that have contributed to past aircraft mishaps and make these factors available to users with the goal of reducing future aircraft mishap rates.

SUMMARY: The Human Factors Analysis and Classification System-Maintenance Extension taxonomy (HFACS-ME), a framework for classifying and analyzing the presence of maintenance errors that lead to mishaps, incidents, and personal injuries, is the theoretical foundation for the system. An existing desktop mishap application was updated, a prototype web-based model was developed and an Asynchronous Distributed Learning (ADL) module was conceptualized. These tools were designed to facilitate data collection, organization, query, analysis, and the reporting of maintenance errors that contribute to aviation mishaps. Together they represent a complete, robust system for analyzing aircraft maintenance mishap related factors anywhere at anytime.

PROJECT SUMMARIES

PUBLICATIONS:

Zolla, G, Boex, T., Flanders, P. and Nelson, D., “Distributed Maintenance Error Information, Investigation and Intervention,” *World Aviation Conference Proceedings*, Seattle, WA, 2001.

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PRESENTATIONS:

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DoD KEY TECHNOLOGY AREAS: Air Vehicles, Computing and Software

KEYWORDS: Aviation Safety, Maintenance Error Information, Mishap Investigations, Distributed Mishap Information